Namal University, Mianwali

Department of Electrical Engineering

Communication Systems (Lab)

Lab – 10

Digital mapping (ASK, FSK, PSK) using MATLAB/Simulink

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Version 1.0 – 27/03/2021 – Engr. Arbaz
Version 1.1 – 27/03/2022 – Engr. Arbaz
Version 1.2 – 20/03/2023 – Engr. Imtiaz Ul Hassan
Version 1.3 – 26/02/2024 – Engr. Faizan Ahmad

Introduction

The purpose of this lab is to enable the students to learn ASK, PSK and FSK using MATLAB.

Course Learning Outcomes

CLO2: Develop software simulations to observe the performance of analog and digital communication systems.
CLO4: Report desired results proofs and calculations.

Equipment

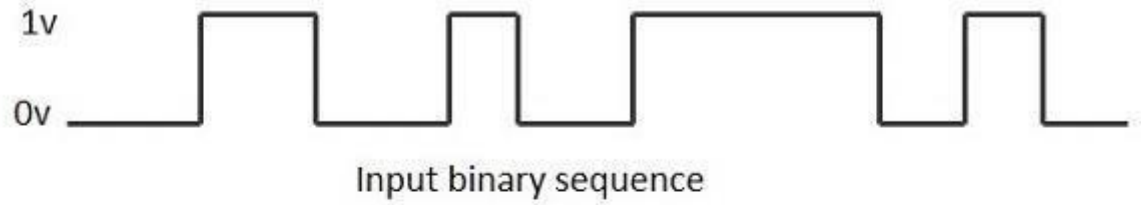
- Software
    - MATLAB

Instructions

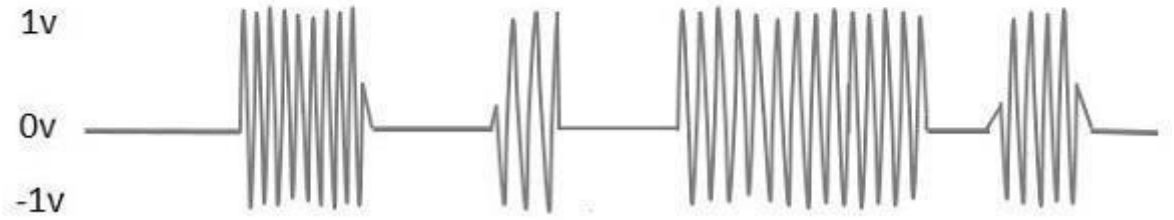
- This is an individual lab. You will perform the tasks individually and submit the required files at the end of the lab.
- Plagiarism or any hint thereof will be dealt with strictly. Any incident where plagiarism is caught, both (or all) students involved will be given zero marks, regardless of who copied whom. Multiple such incidents will result in disciplinary action being taken.

ASK Modulation

Amplitude Shift Keying ASK is a type of Amplitude Modulation which represents the binary data in the form of variations in the amplitude of a signal. Any modulated signal has a high frequency carrier. The binary signal when ASK modulated, gives a zero value for Low input while it gives the carrier output for High input. The following figure represents ASK modulated waveform along with its input.



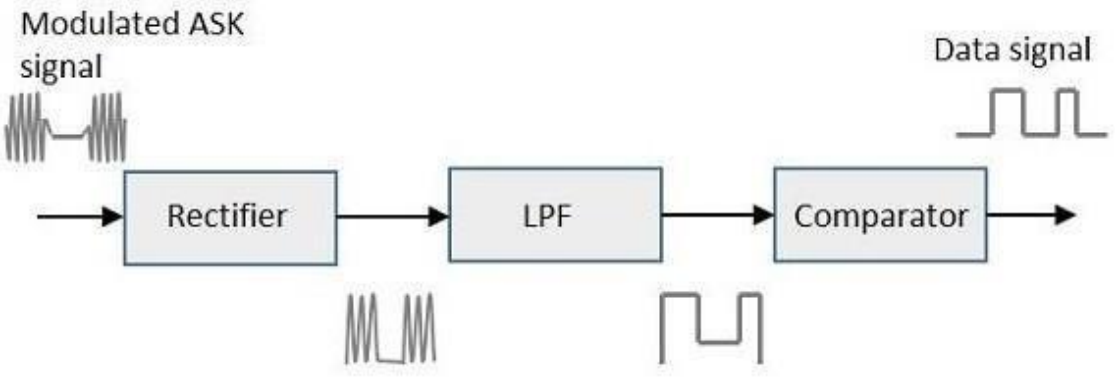
Input binary sequence



ASK Modulated output wave

Demodulation

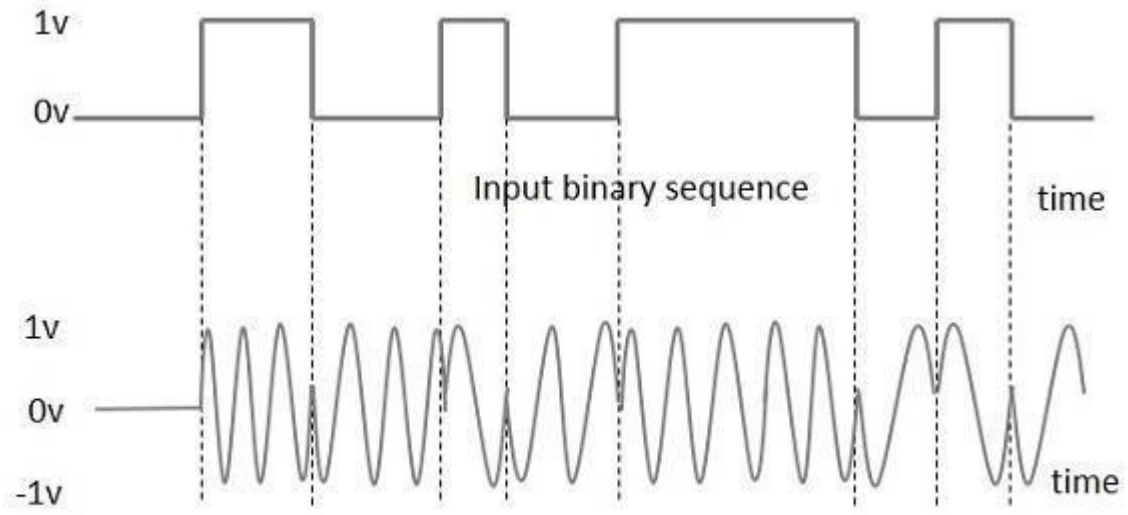
The modulated ASK signal is given to the half-wave rectifier, which delivers a positive half output. The low pass filter suppresses the higher frequencies and gives an envelope detected output from which the comparator delivers a digital output.



Asynchronous ASK detector

PSK Modulation

Phase Shift Keying PSK is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time. PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications.



BPSK Modulated output wave

PSK is of two types, depending upon the phases the signal gets shifted.

1. *Binary Phase Shift Keying BPSK*

This is also called as 2-phase PSK or Phase Reversal Keying. In this technique, the sine wave carrier takes two phase reversals such as 0° and 180°.

2. *Quadrature Phase Shift Keying QPSK*

This is the phase shift keying technique, in which the sine wave carrier takes four phase reversals such as 0°, 90°, 180°, and 270°.

Demodulation

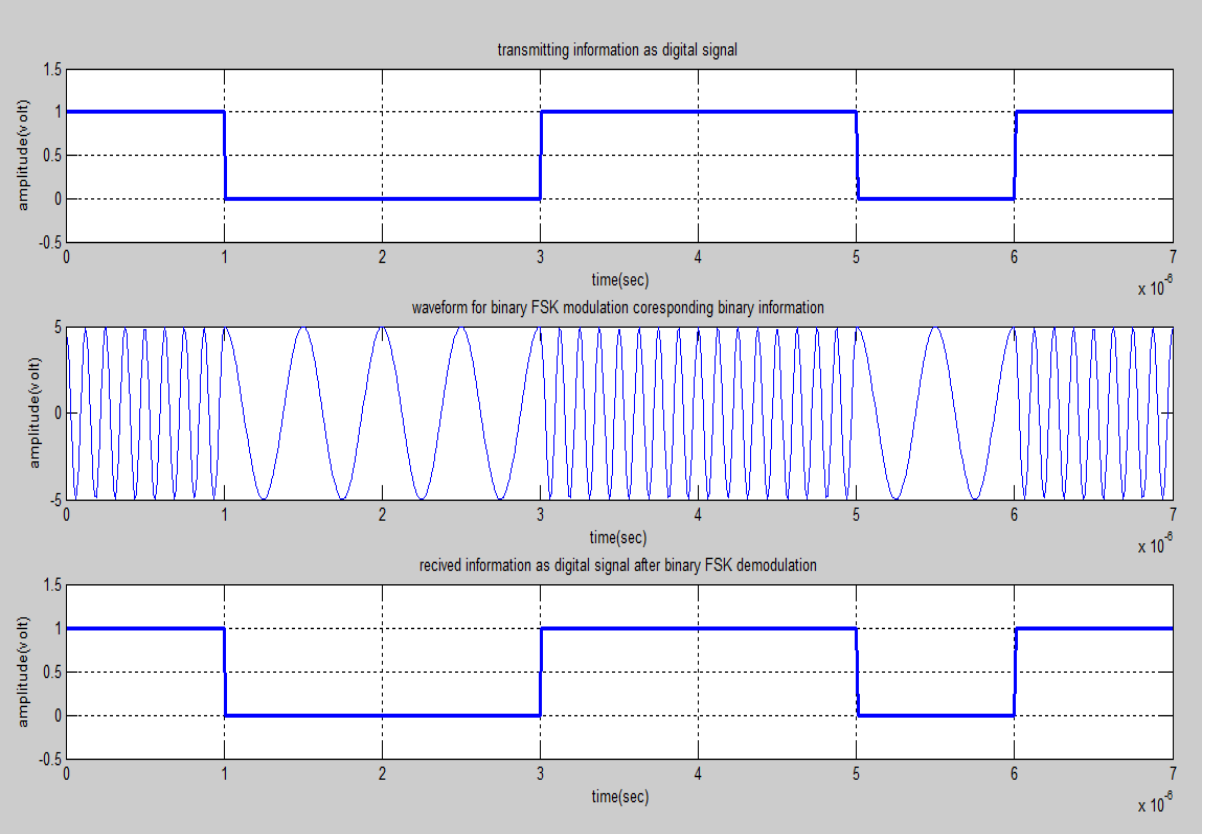
In demodulation of bpsk, multiply with carrier then use Low-Pass Filter.

FSK Modulation

In Frequency Shift Keying (FSK), the instantaneous frequency of the carrier signal is switched between two (or more) values in response to the digital code (e.g. PCM code).

In binary FSK, the binary digital information is modulated to two different frequencies, say f1 and f2 = f1 + Δf.

Thus binary '0' can be expressed by a sinusoidal signal with frequency f1, as u1 = cos2*pi*f1*t. And, binary '1' can be expressed as a sinusoidal signal with frequency f2), as u2 = cos2*pi*f2*t, where f2 = f1+ Δf. Figure below shows a digital signal and the transmitted signal as Binary FSK.



Digital signal and its corresponding FSK modulated signal.

Notice that binary '1' is represented by a sinusoidal signal with frequency f1 and binary '0' by signal with frequency f2.

Demodulation

Demodulation of the binary FSK signal can be done by the non-coherent detection method as shown in the Figure

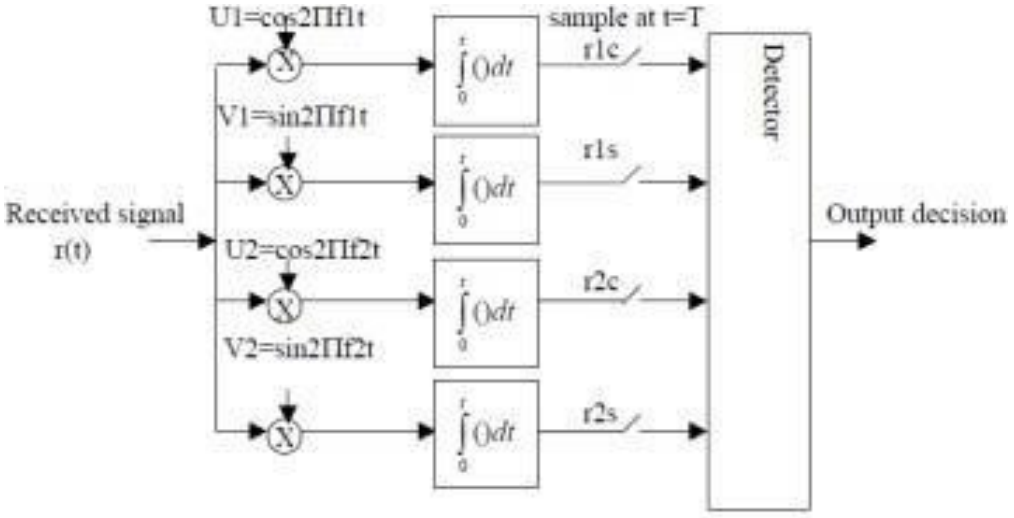


Figure FSK Demodulator Block Diagram

The detector decides the received signal by comparing r1 and r2. To be precise if r1> r2 then the detector decides that the received signal is of frequency f1 (which corresponds to binary '0' at input) and vice versa.

Exercise:

Task 1

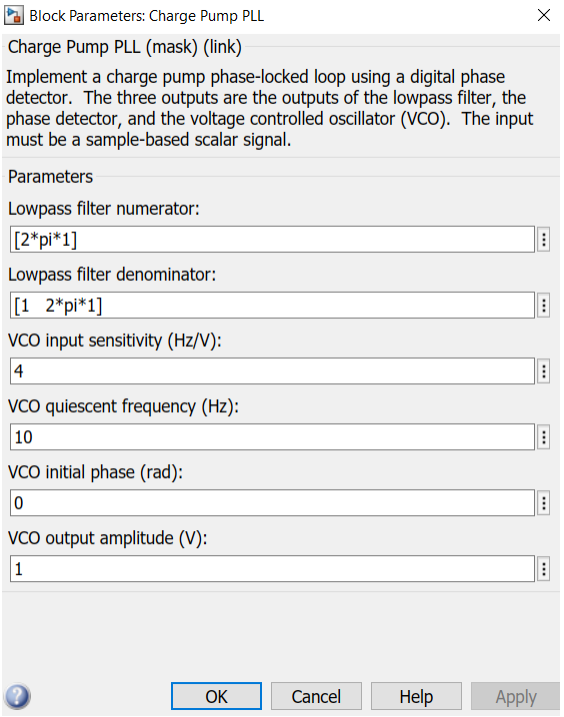
Implement ASK Modulation and Demodulation using Simulink. You can use the following blocks for implementation.

- **Bernoulli Binary**
- **Sine Wave (Set the Frequency of Sine wave 2*pi*4)**
- **Dot**
- **Sign**
- **Scope**

Task 2

Implement FSK Modulation and Demodulation using Simulink. You can use the following blocks for implementation.

- **Bernoulli Binary**
- **Sine Wave (Fc1=2*pi*4 and Fc2=2*pi*12)**
- **Dot**
- **Switch**
- **Relational Operator**
- **Charge Pump PLL**



- **Constant**
- **Scope**

Task 3

Implement PSK Modulation using Simulink. You can use the following blocks for implementation.

- **Bernoulli Binary**
- **Sine Wave**
- **Dot**
- **Scope**

Report

For each exercise, include the code you write, show all outputs, and write your answers/ observations where asked.

Upload your final report (containing general formalities like cover page containing your name and roll number etc.) to QOBE in the report submission folder. Upload your final executable .m file as well in the separate submission folder on QOBE.

Com. Sys. Lab 9 Rubric

Method of Evaluation: Executable code, Report submitted by students **Measured**
Learning Outcomes:
CLO2: Develop software simulations to observe the performance of analog and digital communications systems.
CLO4: Report desired results proofs and calculations.

	Excellent 10	Good 9-7	Satisfactory 6-4	Unsatisfactory 3-1	Poor 0	Marks Obtained
Code (CLO2)	Correct code, easily understandable with comments where necessary	Correct code but without proper indentation or comments	Slightly incorrect code with proper comments	Incorrect code with improper format and no comments	Code not submitted	
Output (CLO2)	Output correctly shown with all Figures/ Plots displayed as required and properly labelled	Most Output/ Figures/ Plots displayed with proper labels	Some Output/ Figures/ Plots displayed with proper labels OR Most Output/ Figures/ Plots displayed but without proper labels	Most of the required Output/ Figures/ Plots not displayed	Output/ Figures/ Plots not displayed	
Answers (CLO2)	Meaningful answers to all questions. Answers show the understanding of the student.	Meaningful answers to most questions.	Some correct/ meaningful answers with some irrelevant ones	Answers not understandable/ not relevant to questions	Wrong Answers	
Lab Report (CLO4)	Report submitted with proper grammar and punctuation with proper conclusions drawn and good formatting	Report submitted with proper conclusions drawn with good formatting but some grammar mistakes OR proper grammar but not very good formatting	Some correct/ meaningful conclusions. Some parts of the document not properly formatted or some grammar mistakes	Conclusions not based on results. Bad formatting with no proper grammar/ punctuation	Report not submitted	
Total						